METHOD AND PLANT FOR THE HOT ROLLING OF RAILS

Field of the invention

The present invention refers to a method and a plant for the production by hot rolling of objects such as metallic beams, in particular railway rails and similar rollable materials.

Background art

Hot rolling production of railway rails in appropriate rolling stands is known.

The rolling operation for a rail generally comprises a break down operation of the ingot or billet in one or more break down stands, optionally the passage in an intermediate working section and then a finishing operation in a finishing stage.

The development of high speed railway lines requires tighter working tolerances on the rails than in the case of normal railway line rails.

A problem underlying the present invention is to provide a method and a plant, for rails rolling, able to produce rails with a higher quality, in terms of dimensional and surface tolerances, while limiting the number of rolling stands.

Such a problem is solved, according to a first aspect of the present invention, by a method for the production of rails and similar products by means of a rolling plant, said plant comprising a reversible intermediate working section able to receive a pre-rough rolled bar from an appropriate upstream rough rolling station and to supply it, after having worked it, to a downstream finishing station, where said intermediate working station comprises:

- a first and a second universal stand;
- a high edging stand placed between said first and second universal stands.

The three above mentioned stands are placed at such a distance between each other so that said bar can be simultaneously held in all three said stands during rolling.

Such a method is characterised by the fact of comprising the following operations in the order indicated:

- a first rolling passage in said second universal stand;
- a first rolling passage in said high edging stand;
- a first rolling passage in said first rolling stand.

According to a second aspect of the present invention, the problem indicated in

more detail above is solved using a rolling plant for the implementation of a method as described above, where such plant comprises a reversible intermediate working section able to receive a pre-rough rolled bar from an appropriate upstream rough rolling station and to pass it, after having worked it, to a downstream finishing station, where said intermediate working station comprises, located in succession along at least one rolling axis, a first universal stand and a high edging stand. The plant according to the present invention is characterised by the fact of comprising a second universal stand located, along said at least one rolling axis, such that said high edging stand is found placed between said first and second universal stand, and said three stands are located at a distance from each other such that said bar can be simultaneously held in all three said stands during rolling.

A further advantage of a method and a plant as described above, besides a good compromise between good dimensional and superficial tolerance and a limited number of rolling stands, is a high productivity.

The limited number of stands produces a lower initial investment cost and a lower cost for the transformation of the product: In fact, being able to perform the rolling with two or three stands rolling simultaneously the same bar at global temperatures higher than in stands not rolling the same bar, and it is therefore possible to reduce the number of rolling passages.

Additionally the three stand intermediate rolling section, with regards to controlling the rolls rotation speed and other process parameters, is relatively simple to control.

According to a further aspect of the present invention, a method for the production of rails and similar products through rolling is described comprising the finishing operation of a bar transformed into a semi-worked rail, characterised by the fact that said finishing operation comprises a rolling passage in a universal stand fitted with a first vertical roll able to work the base of said rail, and a second vertical roll able to work the head (T) of said rail, and said first and second vertical rolls are able to roll said head (T) and said base (B) simultaneously.

Currently, in the rolling of rails, the finishing passage is performed in semi-universal rolling stands -fitted with a single vertical rolling roll- or, sometimes, in

high edging stands.

Such a method of finishing allows the making of rails with better dimensional precision, in particular the height and shape of the head of the rail finished.

Preferred embodiments are also provided which allow the attainment of good surface finishing and further improve the dimensional precision of the rolled rail.

Finishing methods according to this further aspect of the present invention can be used both in combination with intermediate rolling methods, according to the foregoing aspects of the present invention, described more above, and in combination with rail intermediate working methods according to the known art.

List of the figures

Further advantages of the present invention will become apparent, to the skilled person, from the following detailed description of an embodiment given by way of non limiting example, with reference to the following figures, of which:

Figure 1 shows schematically an embodiment of a rolling plant to carry out a method according to the invention;

Figure 2 shows schematically the sequence of rolling operations carried out in the plant of Figure 1, according to an embodiment of a method according to the invention;

Figure 3 shows schematically a sectional view of a finishing stand of the plant of Figure 1 according to a first embodiment of a method according to the present invention;

Figure 4 shows schematically a sectional view of a finishing stand of the plant of Figure 1 according to a second embodiment of a method according to the present invention;

Figure 5 shows schematically a sectional view of a finishing stand of the plant of Figure 1 according to a third embodiment of a method according to the present invention;

Figure 6 shows schematically a sectional view of a finishing stand of a plant of Figure 1 according to fourth embodiment of a method according to the present invention.

Detailed description of the invention

In the present description, the expression "reduction ratio" ρ means the ratio

(optionally expressed as a percentage) between the reduction which the area S of each bar section is subjected at each rolling passage, and the area of the section of the bar prior to the rolling passage, $\rho = (S_{prior} - S_{after})/S_{prior}$.

Figure 1 schematically shows a preferred embodiment of a hot rolling plant for railway rails according to the present invention.

The bars produced, for example from a continuous casting plant (not shown) are firstly rough rolled in a first group of break down stands 1, and optionally in a second group of break down stands 2; then reach an intermediate section, indicated globally by numeral 3. Emerging from said intermediate working section 3, the bars are sent to a finishing station consisting of finishing stand 4 and from this to the successive working stations (plate cooling, thermal treatments etc.).

In the present patent application, the expression "finishing stand" or "finishing station" means the stand of the rolling line which performs the last rolling passage, performing the last dimensional adjustments on the rail.

According to an aspect of the present invention, the intermediate working section 3 comprises, in upstream - downstream direction along the bar rolling line, a first universal stand 30, a second universal stand 32, a two-high edging stand 31 placed between the first and second universal stands 30, 32.

The first and second universal stands 30, 32 and the high edging stand 31 are reversible and located along a single rolling axis, at such distances from each other as to engage all three simultaneously the same bar during rolling (except in the case in which one stand is performing a "dummy" passage, in which the stands simultaneously enaging a bar will be at most two).

Advantageously the distances between the horizontal rolls of the first and second universal stands 30, 32, and the high edging stand 31 are as close as possible: this allows performing the various rolling passages at temperatures on average that are higher, reducing the wear of the rolls or, equivalently, allowing higher reduction ratios at each passage and/or a lower number of passages (in the particular embodiment described it has been possible to reduce the passages to just three).

According to a first aspect of the present invention, the rolling section 3 performs the rolling of the semi-worked bar according to the following method, outlined in

Figure:

The semi-worked bar is subjected to a first rolling passage U1 in the second universal stand 32 –the rolls of the first universal stand 30 are initially opened and therefore perform a first dummy passage D1; then the direction of advancement of the bar is inverted and the bar for working passes again in the intermediate rolling section 3 undergoing a first rolling passage E1 in a first working groove of the high edging stand 31, and then a first passage U2 in the first universal stand 30.

The high edging stand 31 is mobile between different positions, so as to allow the positioning, along the rolling axis of the two universal stands 30, 32, of different grooves or rolling grooves to make different high edging passages.

Advantageously the first rolling passage U1 in the second universal stand 32 is carried out with a reduction ratio $\rho 1$ greater than the reduction ratio $\rho 2$ of the first rolling passage U2 in the first universal stand 30, preferably assuming $\rho 1$ approximately equal to 20% and $\rho 2$ approximately equal to 16%; however such values can be varied and adapted as a function of the specific needs (such as for example shape and dimensions of the rails to roll, temperature etc.). Preferably $\rho 1$ is selected from between approx. 10% and approx. 30%, and $\rho 2$ is selected from between approx. 3% and approx. 25%.

Advantageously, before undergoing the first rolling passage U1 in the universal stand 32, the bar originates from the two break down mills 1 and 2 is further broken down with a rolling passage E2 in a second rolling groove of the high edging stand 31: if present, the intermediate section 3 at such a distance from the break down mill 1, 2 so that the bar, when being worked in the intermediate section 3 is no longer held by the rolls of the break down mills 1, 2, The operation E2 can be performed in the shadow of other operations of such break down mills 1, 2 suppressing a working passage from them and reducing the overall rolling time.

Preferably, when the bar passes again, in a downstream – upstream direction, the intermediate working section 3, following the reversal of movement of the next bar to the first rolling U1 in the second universal stand 32 and prior to the first rolling passage E1 in the high edging stand 31, the bar is subjected to a second rolling passage U3 in the second universal stand 32 (to carry out the passage U3,

following the passage U1 the rolls of the stand 32 are brought closer): as said before, the first rolling passage U2 in the first universal stand 30, the first rolling passage E1 in the high edging stand 31 and the second rolling passage U3 in the second universal stand 32 can be carried out with the three stands 30, 31, 32 simultaneously holding the bar (rails generally have final lengths varying from 60 m to over 100 m; the crop ends used to make spares and other extra elements have shorter lengths instead).

According to the preferred working cycle outlined in Figure 2, following the first rolling passage U2 in the first universal stand, the direction of advancement of the bar is again inverted and the bar subjected to a second rolling passage U4 in the first universal stand 30 (in the same rolling rolls as the passage U2, but to carry out the passage U4 the rolls of the stand 30 are brought closer together), and successively a third rolling passage E3 in a third rolling groove of the high edging stand 31; the rolls of the second stand 32 are now opened and do not perform any rolling of the on the bar (second dummy passage D2), which is sent to the finishing station 4.

Preferably the rolling passage U3 is carried out with a reduction ratio $\rho 3$ comprised between around 10% and around 30%, and in particular approximately equal to 16%, the rolling passage U4 is carried out with a reduction ratio $\rho 4$ comprised between around 3% and around 20%, and in particular approximately equal to 8%.

According to the preferred working cycle just described, the break down and the hardest rolling passages U1 (and optionally U3), with the largest reduction ratios, are only carried out in the second universal stand 32, whilst the passages U2 (and optionally U4) which, with smaller reduction ratios, are all carried out in the first universal stand 30: in this way the greatest wear of the break down operations and the initial deformations U1, U3 involve only the second universal stand 32, whilst the successive rolling passages U2, U4 –which can be considered the pre-finishing passages- are exclusively carried out in the first universal stand 30, which is therefore subjected to less wear and manages to ensure tolerances –of shape and surface finishing- sufficiently precise on the bar emerging from section 3, for a longer working lifetime with respect to plants in which both break down and rough rolling passages and the final pre-finishing passages are performed in an

intermediate rolling section on the same universal stand: in fact, in the working cycle of Figure 2, the first universal stand 30 compensates for the deviations in shape which the bar receives from the second universal stand 32 which deteriorates more quickly.

Also, the surface finishing of the rolled rail with the methods according to the present invention are better: In fact, the reduced wear during working, of the stand rolls 30 enables to reach longer periods of time of smoother surfaces of the rolled rails, with respect to the rolling plants of known type.

The structure of the intermediate section 3 substantially only of three stands, does not require excessively complex roll speed control systems; re-equipping times can be reduced and it is simpler to administer the production of small batches.

In comparison to other installations one obtains equal quality and tolerances on the product emerging with a fewer number of stands, and therefore one has a saving on the initial investments.

The working with reversible stands ensures more uniform temperature distribution over the bar, for example, with respect to a continuous rolling process.

Advantageously, the finishing station 4 is at such a distance, from the intermediate section 3, that a bar is never held simultaneously in a section three stand 3 and the finishing station 4; this, in addition to allowing simultaneously carrying out, and with less dead time, the intermediate rolling and the finishing, eliminates the bar deformations which would occur if this was held both in section 3 and in the station 4: in such a case in fact, the speed of the stands 30, 31, 32 and the finishing stands 4 even if controlled with appropriate control systems, would be however subject to relative slippages more or less important, from which there would be dilation, deformations and in general dimensional variations of the bar.

The finishing station 4 can comprise, as is currently normal practice, a semi-universal rolling stand (i.e. with two horizontal rolls 40, 41 and one vertical roll 42, Figure 3; the vertical roll 42 rolls and finishes the lower surface of the base of resting of the rail) or also a high edging stand (Figure 4).

According to a preferred embodiment of a method according to the present invention (Figure 5), the finishing station 4 can advantageously comprise a universal stand with two horizontal rolls 400, 401 and two vertical rolls 402, 403,

where the vertical roll 402 works and finishes the base of the rail B, whilst the second vertical roll works and refinishes the area of the head T of the semi-worked rail; the two vertical rolls 402, 403 refinish the base and head of the rail working simultaneously.

The use of a universal stand with two vertical rolls (Figure 5, 6) is a further factor which enables reaching more precise tolerances on the overall height of the rails.

Still with reference to Figure 5, generally the head T of a rail comprises a rollable central surface T1, on which the wheels of the railway vehicle rest, and the two lateral flanks T2, T3 substantially rectilinearly oriented or vertically or with a slight inclination with respect to the vertical when the rail is installed; on the lateral flanks T2, T3 the wheels of the railway vehicles laterally rest.

The central rollable surfaces T1 and the two lateral flanks T2, T3 are joined by two curved areas T4, T5.

The vertical rolling roll 403, which deforms and refinishes the head T of the rail, comprises a rolling groove 404 able to plastically deform and refinish the head T; The groove 404 comprises a central area –able to plastically deform and refinish the central rollable section T1 of the head- and two lateral surfaces located to the sides of said central zone and able to retain and shape the lateral flanks T4, T5 of the head T of the rail.

The other roll 402 has a normal flat rolling surface to finish the lower face of the base B of the rail.

The shape of the groove 404 allows to retain and shape with greater precision not just the central rollable area T1 of the head T of the rail, but also the flanksT4, T5 of the head.

Returning to the rolls of the traditional semi-universal finishing stand of Figure 3, in general the difference between the different speed of rotation of a rolling groove in the different points P1-P10 produces, on the surfaces of the rolled bar, an undesired slipping effect in some areas of the metal of the bar; for this reason the depth of the rolling grooves is not excessively big.

By comparing the sections of the rolling grooves of the rolls of Figures 3 and 5, one remarks that the rolls of the kind of Figure 5 can be made with rolling grooves 404 which do not give rise to excessive slipping effects on the surface of the rail;

since the slipping effect is increased with reduction in the average diameter of the groove, it is preferable to choose large diameters for the vertical rolls 402, 403.

Figure 6 shows a further embodiment of a universal finishing stand with two vertical rolls 422, 423 developed by the applicant:

in such an example the groove 424 which shapes the head T of the rail is less deep and deprived of the lateral flanks able to shape and retain the lateral flanks T2, T3 of the head of the rail; the groove 424 rolls and finishes only the central area T1 of the head of the rail; in this way the problem of slipping due to the rotational speed gradient along the surface of the groove 404 is overcome.

The finishing stand of Figure 6 is also itself fitted with a second roll 422 to shape and finish precisely the lower side of the base B of the rail.

The two vertical roll finishing stands just illustrated can be used as finishing stations not just in the plants realised according to the present invention, but also in mills of a different kind, for example having intermediate sections of known type.

Independently of the type of stand used for finishing (semi-universal, universal or high edging) preferably the finishing passage UF in the stand 4 (Figure 1, 2) is performed with a reduction ratio ρF comprised of between around 1% and around 15%, and in particular with a reduction ratio ρF equal to around 2%: such a reduction ratio, particularly small, optionally coupled with the pre-finishing action of the optional passages U2 and U4 carried out as previously described, enables to reach rather precise dimensional and surface finishing tolerances and more constant over time, with respect to the finishing methods of the known art.

The described embodiments are susceptible to many variations without departing from the scope of the present invention: for example it is possible to change by adding or removing rolling stands to carry out the various passages. If required by the floor space of the building in which the plant is housed the number of passages of the bar through the intermediate section 3 can also be even, and not necessarily uneven as previously described, so that the rail, at the end of the rolling cycle is expelled from the section 3 from the same side as into which it was introduced, rather than crossing the section 3 and continuing downstream.

Every modification and variation falling within the meaning of the field of equivalence of the claims is intended as being comprised within them.